MODELING AND DESIGN CONTROL STRATEGY FOR UNWIND/REWIND SYSTEM

MUHAMAD FAHEZAL BIN ISMAIL

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Universiti Teknologi Malaysia

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ABSTRACT

This paper presents the mathematical modeling and designing a control strategy for unwind and rewind system. Unwind and rewind system is widely used in industry that involved the web transportation such as textile, plastic, paper and metal. Basically, the unwind and rewind system consists of three motors which are to control the Unwind, Traction and Rewind. Currently, the system used Programmable Logic Controller (PLC) to control the whole system operation. Strain gauge is used for the system feedback. This project was replaced the PLC to computer controlled method. A new control algorithm that based on the regulator feedback was proposed. The tension observer is introduced as a regulator feedback and dynamic simulation requirement.The mathematical modeling of the system is established base on the tension control, speed control and other elements related to the system. In the control strategy, PID (Propotional Integral and Differential) controller is used to the tension controller and speed controller for simulation and experiment. The xPC-target box is used as a prototype controller to the unwind and rewind tension and speed synchronization. The validation process of the results was performed for both simulation and experimental to see the performance of the system.

ABSTRAK

Kertas ini mempersembahkan pemodelan matematik dan strategi kawalan untuk sistem tidak mengulung dan mengulung. Sistem tidak mengulung dan mengulung ini banyak digunakan dengan meluas dalam industri pengulungan seperti tekstil, plastik, kertas dan besi. Secara asasnya, sistem tidak mengulung dan mengulung mempunyai tiga buah motor digunakan untuk kawalan pada tidak mengulung, treksi(pandu arah), dan mengulung. Pada masa sekarang sistem tersebut menggunakan Kawalan Logik Berprogram ("PLC") untuk kawalan seluruh operasi sistem tersebut. Kawalan Logik Berprogram telah digantikan dengan kaedah kawalan mengunakan komputer dalam projek ini. Algoritma kawalan baru berasaskan sistem kawalan balas telah direka. Pemerhati tegangan diperkenalkan sebagai kawalan balas dan juga untuk memunuhi keperluan simulasi dinamik. Pemodelan matematik dibuat berdasarkan kawalan tegangan, kawalan laju, dan juga elemen-elemen lain yang berkaitan dengan sistem tersebut. Dalam strategi kawalan pula, kawalan perkadaran, kamiran dan pembezaan ("PID") telah digunakan pada kawalan tegangan dan kawalan laju untuk simulasi dan eksperimen."xPC-target box" telah digunakan sebagai kawalan prototaip untuk kesamaan laju dan mengawal tegangan pada sistem tersebut. Proses validasi telah dilakukan pada kedua-dua simulasi dan eksperimen untuk melihat tahap pencapain sistem tersebut.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In the roll to roll method, the web quality depends on the web tension maintained throughout the process. It is essential that the web tension be controlled and maintained at an appropriate level if a satisfactory web quality is required. Various studies have addressed the issue of tension control in web transport systems. Two tension control methods, namely the open loop tension controller and the closed-loop tension controller with observer-based tension feedback (simulation) and strain gauge (experimental).

Feedback tension control using tension transducer is mostly used in the web industry. Now, low cost and high productivity are two primary goals in design of web transport system. One approach to achieve low cost is through the implementation of observer technique in replace tension transducer. To achieve high productivity, it is normally required to increase the speed process. However, as the process speed or variation of the speed is high, system friction and inertia of rotation of rolls could cause problems in implementation of observer techniques for tension estimation and control.

A new tension control algorithm with tension observer is proposed using observed tension as a regulator feedback. The tension observer is based on the torque balance of a roller stand, including the acceleration torque. Using this estimated tension, the new tension controller can be constructed with faster dynamic response in case of line speed acceleration or deceleration. The proposed scheme needs no additional hardware because the inputs of observer, current and speed are already being monitored by the motor drive system. The proposed controller is compared to the conventional controllers through simulations and experiments.

1.2 Objective:

The objectives of this project are as follow:

i To establish the mathematical model of unwind/rewind system.

ii To setup experimental and simulation as a main methodology of the project.

iii To study the control performance of the system based on the results obtained from simulation and experiment.

1.3 Scope of Work

The scope of work is clearly to establish mathematical model of unwind/rewind system and study control performance of the system using Matlab and Simulink. (Simulation). The next step is to plan experimental design, setup and perform the experiment. Finally the validation process will be done based on the simulation result and the experimental results. The scope of work can be described in the flow chart as shown in Figure 1.1.

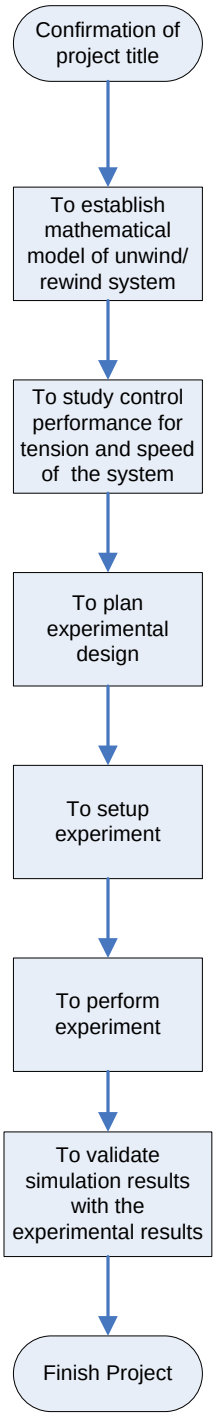

Figure 1.1: Flow chart represents the scope of work

1.4 Project Background

Winder machine is widely used in industry that involved winding operation such as textile, paper, plastic, and metal. Basically, the winder machine system consists of three motors which are to control the Unwind, Traction and Winder. Currently, the system used PLC (Programmable Logic Controller) to control the whole system operation. Load cell or strain gauge is used for the system feedback. Previously the system doesn't have any control algorithm applied.

This project will replace the PLC to computer controlled method. A new control algorithm that based on the regulator feedback will be proposed. The tension observer is introduced as a regulator feedback. Then, a real time control will be applied to control the whole system. The synchronization of the unwind speed and rewind speed is the main concentration to overcome the twisted problem occurred with previous controller. This project will used the x-PC target box as an interface instrument from PC to Unwind/Rewind system for real time control as shown in Figure 1.2.

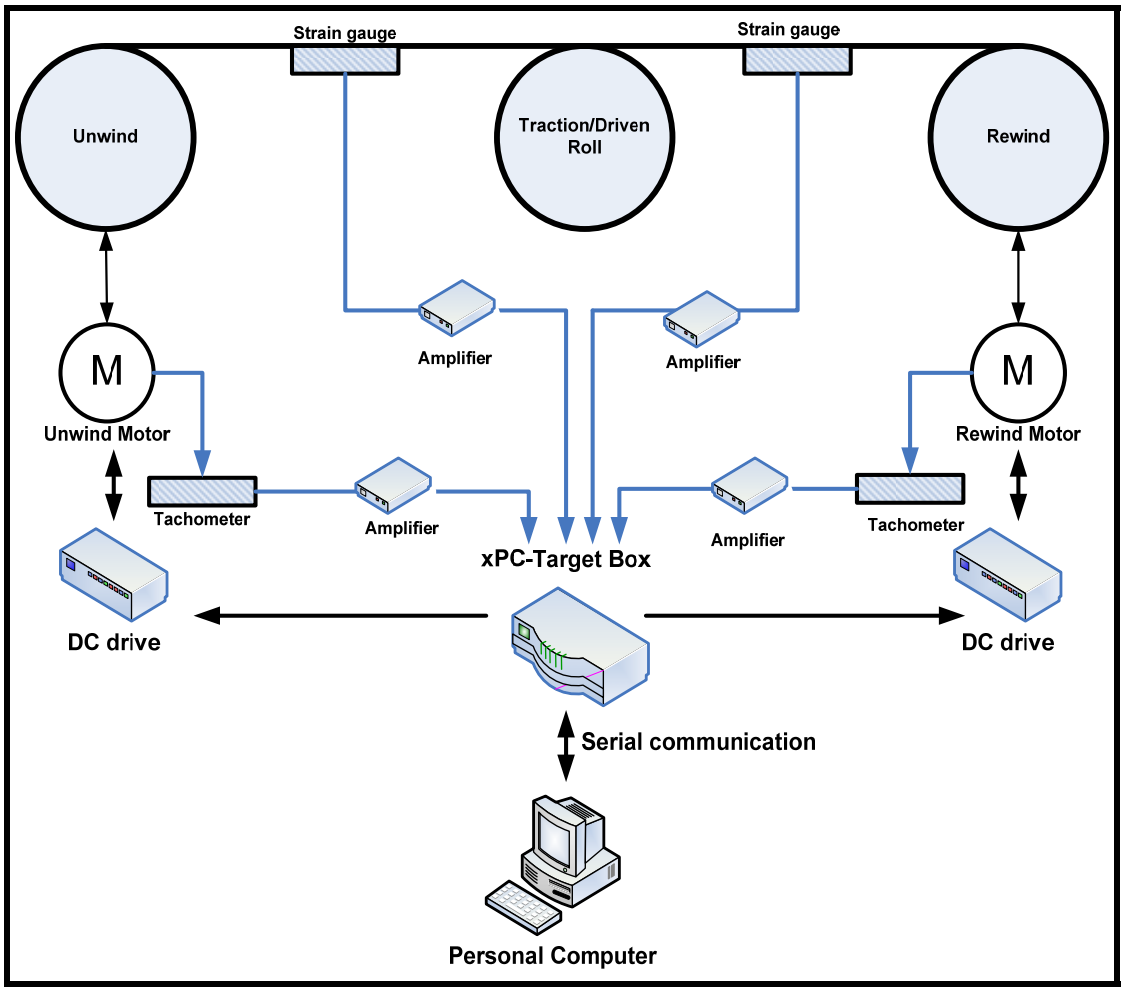

Figure 1.2: The real-time implementation setup for unwind/rewind system.

1.5 Outline of the Thesis

The thesis presents the implementation of the mathematical modeling of Unwind/rewind system and designs a control strategy for the system.

Chapter 2 focuses on the literature review, which introduces the overview of Unwind/Rewind system and tension issue. The explanation begins with the previous researches on web transport system which is similar to Unwind/Rewind. This chapter is then described by related researches on the mathematical modelling of unwind/rewind system, which is found to be related and facilitate to this project.

Chapter 3 provides the methodology that is used through out the work of this project. It covers the technical explanation of this project, derivation of the dynamic model mathematical equations using related formula and performing the experiment. Then the model will be verified with the simulation results and experimental results.

Chapter 4 deals with the time response results and Matlab/Simulink simulation results of the dynamic model and the real time results. The simulation results are being compared with the experimental results for model validation.

Chapter 5 presents the conclusions of the project as well as some constructive suggestions for further development and the contribution of this project. The project outcome is concluded in this chapter. As for future development, some suggestions are highlighted with the basis of the limitation of the effectiveness mathematical equation and simulation analysis executed in this project.